WHAT IS CLAIMED IS:

1. A linear power amplifier comprising:

a digital predistorter supplied with a digital transmission signal, for predistorting said digital transmission signal by use of a power series model to generate a predistorted signal;

a DA converter for converting said predistorted signal from said digital predistorter into an analog predistorted signal;

a frequency upconverting part for upconverting said analog predistorted signal to a transmit frequency band;

a power amplifier for power-amplifying said upconverted signal;

a frequency downconverting part for downconverting a portion of the output from said power amplifier to output a downconverted signal; and

a digital predistorter control part for extracting distortion components of the same odd orders as those of said power series model and for controlling coefficients of said predistorter in a manner to lower the levels of said odd-order distortion components.

2. The linear power amplifier of claim 1, which further comprises a pilot signal generator for generating a digital pilot signal for input to said digital predistorter, and wherein said digital predistorter control part includes means for extracting odd-order distortion components of said pilot signal and for controlling the coefficients of said digital predistorter based on said extracted odd-order distortion components.

3. The linear power amplifier of claim 1, which, letting said digital predistorter, said DA converter and said frequency upconverting part be referred to as a first digital predistorter, a first DA converter and a first frequency upconverting part, further comprises:

a pilot signal generator for generating a digital pilot signal;

a second digital predistorter supplied with said digital pilot signal, for predistorting said digital pilot signal by use of a power series model to generate a predistorted pilot signal;

a second DA converter for converting said predistorted pilot signal to an analog signal;

a second frequency upconverting part for upconverting said analog predistorted pilot signal by use of a predetermined frequency; and

a combiner for combining the output from said second frequency upconverting part and said analog predistorted transmission signal, and for inputting said combined signal to said frequency upconverting part.

4. The linear power amplifier of claim 1, which, letting said digital predistorter, said DA converter and said frequency upconverting part be referred to as a first digital predistorter, a first DA converter and a first frequency upconverting part for conversion to a first frequency, further comprises:

a pilot signal generator for generating a digital pilot signal;

a second digital predistorter supplied with said digital pilot signal, for predistorting said digital pilot signal by use of a power series model to generate a predistorted pilot signal;

a second DA converter for converting said predistorted pilot signal to an analog signal;

a second frequency upconverting part for upconverting said analog predistorted pilot signal to a send frequency band by use of a predetermined second frequency different from said first frequency; and

a combiner for combining the output from said first frequency upconverting part and the output from said second frequency upconverting part, and for inputting said combined output to said power amplifier.

5. The linear power amplifier of any one of claims 2, 3 and 4, wherein said first frequency upconverting part converts said pilot signal to a frequency different from the frequency of said transmission signal.

6. The linear power amplifier of any one of claims 2, 3 and 4, wherein said digital predistorter includes: delay means for delaying said digital pilot signal and said digital transmission signal; distortion generating means for generating, in said digital pilot signal and said digital transmission signal, one or more predetermined odd-order ones of the distortion components expressed by a power series model; and adding means for combining said odd-order distortion components and the output from said delay means to provide said predistorted signal.

7. The linear power amplifier of any one of claims 2, 3 and 4, wherein said frequency downconverting part includes an AD converter for converting said pilot signal component to a digital signal.

8. The linear power amplifier of claim 5, wherein said pilot signal is a combined version of two tone signals of different frequencies but of the same level.

9. The linear power amplifier of claim 5, wherein said pilot signal is a modulated signal of a band narrower than that of said transmission signal.

10. The linear power amplifier of any one of claims 2, 3 and 4, wherein said digital predistorter control part includes: a distortion component extracting part for detecting said predetermined one or more odd-order ones of the distortion components, expressed by a power series model of said pilot signal, from said digital pilot signal component; and odd-order distortion characteristic control part for controlling, based on said detected distortion components, phases and amplitudes of the corresponding one or more predetermined odd-order distortion components to be generated by said

digital predistorter.

11. The linear power amplifier of any one of claims 2, 3 and 4, wherein said digital predistorter control part includes:

delay means for generating a delayed digital pilot signal from said digital pilot signal;

distortion generating means for generating distortions of other odd orders than said predetermined odd orders from said digital pilot signal;

subtracting means for subtracting said delayed digital pilot signal and said distortions of said other odd orders from said pilot signal component to detect said desired odd-order distortion components; and

an odd-order distortion characteristic control part for controlling, based on said detected odd-order distortion components, phases and amplitudes of the corresponding one or more predetermined odd-order distortion components to be generated by said digital predistorter.

12. The linear power amplifier of claim 2, further comprising:

a band separator for separating a predistorted transmission signal component and a predistorted pilot signal from said predistorted signal, and for inputting said predistorted transmission signal component to said DA converter;

a second DA converter for said predistorted pilot signal component to an analog predistorted pilot signal component;

a second frequency upconverting part for upconverting said analog predistorted pilot signal component to said send frequency band by use of a second frequency different from a frequency used by said frequency upconverting part; and

an adder for combining the output from said DA converter and the output from said second frequency upconverting part, and for inputting said

combined output as said predistorted signal to said frequency upconverting part.

13. The linear power amplifier of claim 2, further comprising:

a band separator for separating a predistorted transmission signal component and a predistorted pilot signal from said predistorted signal, and for inputting said predistorted transmission signal component to said DA converter;

a second DA converter for said predistorted pilot signal component to an analog predistorted pilot signal component;

a second frequency upconverting part for upconverting said analog predistorted pilot signal component to said send frequency band by use of a second frequency different from a frequency used by said frequency upconverting part; and

an adder for combining the output from said DA converter and the output from said second frequency upconverting part, and for inputting said combined output as said predistorted signal to said power amplifier; and

wherein said frequency downconverting part downconverts said extracted pilot signal by use of said second frequency.

14. The linear power amplifier of claim 1, wherein: said digital predistorter includes distortion generating paths each containing a series connection of a distortion generator for generating one of distortions based on said power series model and a frequency characteristic compensator, and an adder for adding odd-order distortions from said distortion generating paths to said digital transmission signal and for outputting said combined output as said predistorted signal; an said digital predistorter control part includes means for controlling frequency characteristics of said frequency characteristic compensators based on said extracted odd-order distortion

components.

15. The linear power amplifier of claim 14, wherein said digital predistorter includes:

a linear transfer path and said distortion generating path to which said digital transmission signal is divided;

a gain adjuster and a phase adjuster disposed at the output side of said distortion generator on said distortion generating path, for adjusting amplitudes and phases of said odd-order distortions;

a delay device disposed in said liner transfer path; and

a combiner for combining the output from said linear transfer path and the output from said distortion generating path, and for outputting the combined output as said predistorted signal; and

wherein said digital predistorter control part includes an odd-order distortion characteristic control part for controlling said gain adjuster and said phase adjuster to adjust the amplitudes and phases of said odd-order distortions.

16. The linear power amplifier of claim 14, wherein said frequency characteristic compensators are formed by FIR filters whose frequency characteristics are controlled by said extracted odd-order components.

17. The linear power amplifier of claim 14, wherein said frequency characteristic compensators each include: a Fourier transformer for transforming a time domain digital signal to a frequency domain digital signal; a coefficient multiplier for multiplying said frequency domain digital signal by a coefficient based on one of said odd-order distortion components; and an inverse Fourier transformer for transforming the output from said coefficient multiplier to a time domain digital signal.

18. The linear power amplifier of claim 14, further comprising a pilot signal generator for generating a pilot signal of a band different from the

band of said transmission signal, and for providing said pilot signal to said digital predistorter, wherein said digital predistorter control part extracts odd-order distortions of said pilot signal as said odd-order distortion components.

19. The linear power amplifier of claim 14, further comprising:

a pilot signal generator for generating a pilot signal;

another digital predistorter having the same configuration as that of said digital predistorter and supplied with said pilot signal;

another DA converter for converting the output from said another digital predistorter to an analog signal;

another frequency upconverting part for upconverting the output from said another DA converter to a band different from the band of said transmission signal; and

a combiner for combining the output from said DA converter and the output from said another DA converter, and for providing said combined output to said frequency upconverting par; and wherein said digital predistorter control part extracts odd-order distortion components of said pilot signal as said odd-order distortion components.

20. The linear power amplifier of claim 18 or 19, wherein said pilot signal is a combined version of two tone signals of different frequencies but of the same level.

21. The linear power amplifier of claim 18 or 19, wherein said pilot signal is a modulated signal of a band narrower than the band of said transmission signal.

22. The linear power amplifier of any one of claims 14, 16 and 17, further comprising a pilot signal generator for generating two digital pilot signal of the same amplitude, said two digital pilot signals being input to said

digital predistorter and thence to said power amplifier via said DA converter and said frequency upconverting part, and wherein said digital predistorter control part includes: a distortion component detecting part for detecting, as said odd-order distortion components, intermodulation distortion components resulting from amplification of said two digital pilot signals by said power amplifier; and a frequency characteristic control part for estimating frequency characteristics of a transmission route from said intermodulation distortion components detected by said distortion component detecting part, and for controlling frequency characteristics of said frequency characteristic compensators.

23. The linear power amplifier of claim 22, wherein said digital predistorter control part includes a frequency controller for controlling said pilot signal generator to change the frequency interval between said two digital pilot signals.

24. The linear power amplifier of claim 22, wherein said frequency upconverting part includes a local oscillator for generating a variable frequency local signal for upconverting said analog predistorted signal by a variable frequency, and said digital predistorter control part includes a frequency controller for causing said pilot signal to perform discontinuous frequency sweep in the operating band of said power amplifier by discontinuous frequency sweep of the oscillation frequency of said local oscillator.

25. The linear power amplifier of claim 14, wherein said frequency characteristic compensators are each disposed at the input and/or output side of the corresponding distortion generator.

26. A digital predistorter setting method for said linear amplifier of ant one of claims 2, 3 and 4, said method comprising the steps of:

(a) generating a digital pilot signal;

(b) combining said digital pilot signal and said digital transmission signal, generating distortion components of a predetermined number of odd-orders based on a power series model, and adding said odd-order distortion components to generate a predistorted signal;

(c) converting said predistorted signal to an analog predistorted signal;

(d) upconverting said analog predistorted signal to the send frequency band by a predetermined carrier frequency;

(e) power amplifying said upconverted signal;

(f) downconverting a portion of said power-amplified output signal and outputting a pilot signal component; and

(g) controlling coefficients of said digital predistorter based on said pilot signal component so that levels of said odd-order distortion components by said power series model become lower.

27. The method of claim 26, wherein said step (g) includes a step of repeatedly adjusting the coefficients of said digital predistorter so that the level ratios of said odd-order distortion components to said transmission signal becomes smaller go down below a predetermined value.

28. The method of claim 26, wherein said step (a) includes a step of generating, as said pilot signal, two digital tone signals of the same level but of different frequencies.

29. A predistorter setting method for said linear power amplifier of claim 14, said method comprising the steps of:

(a) setting the frequency interval between said two pilot signals;

(b) measuring upper- and lower-side distortion components of said pilot signals from the output from said power amplifier;

(c) comparing said upper- and lower-side distortion components with preset reference values, determining gains and phases of the corresponding frequencies of said frequency characteristic compensators so that said upper- and lower-side distortion components become smaller than said reference values, and storing values of said determined gains and phases in storage means;

(d) repeating said steps (a), (b) and (c) a plurality of times while changing said frequency interval between said two pilot signals for each round of steps;

(e) obtaining frequency characteristics of gains and phases by interpolation from said values of the gains and phases for respective frequencies stored in said storage means; and

(f) setting said frequency characteristics of said gain and phases in said frequency characteristic compensators.

30. A digital predistorter setting method for said linear power amplifier of claim 14, said method comprising the steps of:

(a) setting local oscillation frequency of said frequency upconverting part;

(b) measuring distortion components of a pilot signal from the output from said power amplifier;

(c) comparing said measured distortion components with preset reference values, determining gains and phases of the corresponding frequencies of frequency characteristic compensators so that said distortion components become smaller than said reference values, and storing said values of the determined gains and phases in storage means;

(d) repeating said steps (a), (b) and (c) a plurality of times while changing said frequency interval between said two pilot signals for each

round of steps;

(e) obtaining frequency characteristics of gains and phases by interpolation from said values of the gains and phases for respective frequencies stored in said storage means; and

(f) setting said frequency characteristics of said gain and phases in said frequency characteristic compensators.

31. The digital predistorter setting method of claim 29 or 30, further comprising a step of setting phase adjusters and gain adjusters on said distortion generating path so that said measured distortion components become smaller than predetermined fixed values.

32. A linear power amplification method comprising the steps of:

(a) inputting a digital signal to a digital predistorter, and adding said digital signal with a predetermined number of odd-order distortion components based on a power series model to generate a predistorted signal;

(b) converting said predistorted signal to an analog predistorted signal;

(c) upconverting said analog predistorted signal to a send frequency band by use of a predetermined carrier frequency;

(d) power amplifying said upconverted signal;

(e) downconverting a portion of said power-amplified output signal to extract odd-order distortion components; and

(f) controlling coefficients of said digital predistorter so that the level ratios of said odd-order distortion components to a transmission signal each become smaller than a predetermined value.

33. The linear power amplification method of claim 32, wherein said step (a) includes the steps of: generating a digital pilot signal; and combining said digital pilot signal and a digital transmission signal, and outputting said

combined output as said digital signal.

34. The linear amplification method of claim 33, wherein said step (a) is the step of combining two digital tones signals of different frequencies but of the same level to generate said digital pilot signal, and said step (e) is a step of extracting odd-order distortion components of said digital pilot signal.

35. The linear power amplification method of claim 32, wherein said step (a) includes the step of controlling frequency characteristics of said odd-order distortion components by frequency characteristic compensators, and said step (f) includes the step of repeatedly adjusting coefficients of said frequency characteristic compensators so that the level ratio of said extracted odd-order distortion components to said transmission signal level become smaller than predetermined values.

36. The linear power amplification method of claim 32, wherein said step (f) further includes the step of repeatedly controlling gains and phases of said odd-order distortion components by said digital predistorter in a manner to decrease the levels of said extracted odd-order distortion components.